PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04R 25/00 | A1

(11) International Publication Number: WO 97/34443

(43) International Publication Date: 18 September 1997 (18.09.97)

(21) International Application Number: PCT/US97/03481

(22) International Filing Date: 14 March 1997 (14.03.97)

(30) Priority Data:
60/013,426 14 March 1996 (14.03.96) US

(71) Applicant: SARNOFF CORPORATION [US/US]; 201 Washington Road, CN 5300, Princeton, NJ 08540 (US).

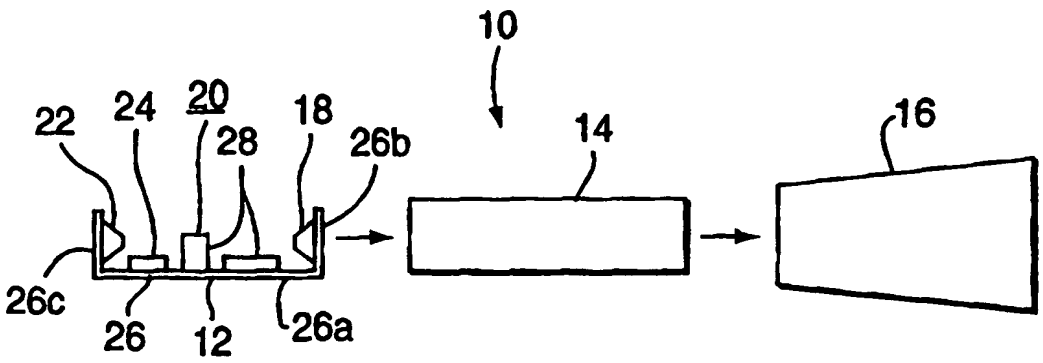
(72) Inventors: ACETI, John, G.; 7 Monroe Drive, Cranbury, NJ 08512 (US). LEEDOM, Marvin, A.; 26 Cleveland Lane, R.D. #4, Princeton, NJ 08540 (US). SJURSEN, Walter, P.; 6 Bankers Drive, Washington Crossing, PA 18977 (US).

(74) Agents: SILVERIO, John, V. et al.; Sarnoff Corporation, 201 Washington Road, CN 5300, Princeton, NJ 08540 (US).

(81) Designated States: CA, JP, KR, MX, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DISPOSABLE HEARING AID



(57) Abstract

A hearing aid (10) includes an electronic assembly (12) mounted in a cylindrical shell (14) with the shell (14) being mounted in an opening in an ear mold (16). The electronics assembly (12) inclludes a printed circuit strip (26) having thereon a speaker (22), a microphone (18) and electronic components forming a signal processing circuit (20) for amplifying the sound. The ear mold is of a soft, durable and compliant material so that it will fit tightly in the ear of a user. The hearing aid is of optimum design having a minimum number of components and is easy to assemble on an automatic basis. This provides a hearing aid which is relatively inexpensive so as to be disposable.

AM

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	**GB**	United Kingdom	**MW**	Malawi
AT	Austria	**GE**	Georgia	**MX**	Mexico
AU	Australia	**GN**	Guinea	**NE**	Niger
BB	Barbados	**GR**	Greece	**NL**	Netherlands
BE	Belgium	**HU**	Hungary	**NO**	Norway
BF	Burkina Faso	**IE**	Ireland	**NZ**	New Zealand
BG	Bulgaria	**IT**	Italy	**PL**	Poland
BJ	Benin	**JP**	Japan	**PT**	Portugal
BR	Brazil	**KE**	Kenya	**RO**	Romania
BY	Belarus	**KG**	Kyrgystan	**RU**	Russian Federation
CA	Canada	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SG**	Singapore
CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovakia
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LR**	Liberia	**SZ**	Swaziland
CS	Czechoslovakia	**LT**	Lithuania	**TD**	Chad
CZ	Czech Republic	**LU**	Luxembourg	**TG**	Togo
DE	Germany	**LV**	Latvia	**TJ**	Tajikistan
DK	Denmark	**MC**	Monaco	**TT**	Trinidad and Tobago
EE	Estonia	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**UG**	Uganda
FI	Finland	**ML**	Mali	**US**	United States of America
FR	France	**MN**	Mongolia	**UZ**	Uzbekistan
GA	Gabon	**MR**	Mauritania	**VN**	Viet Nam

DISPOSABLE HEARING AID

Field of the Invention

The present invention is directed to a disposable hearing aid, and, more particularly to a hearing aid that is small and very inexpensive so as to be disposable.

Background of the Invention

Modern hearing aids comprise an ear mold having therein the necessary electronic for amplifying sound. Such electronics generally include a microphone for receiving the sound and converting the sound to an electrical signal, an electronic circuit for processing the signal produced by the microphone, a speaker for emitting the amplified sound and a battery for operating the system. The ear mold is generally made of a hard plastic which is specially designed and molded to fill the ear of the party who is to use the hearing aid. The ear mold is made of a hard plastic so as to have a long life and so that it can be periodically cleaned. The electronics of the signal processing circuitry are generally adjusted to meet the specific hearing requirements of the party who is to use the hearing aid. These requirements are obtained by first testing the hearing of the party who is to use the hearing aid. After the desired circuit is determined from the tests, the circuit must be finally adjusted by a hearing aid specialist to meet the final requirements of the party. All of the above features of the structure of the hearing aid and the method of making and adjusting it make the hearing aid relatively expensive. Also, the battery in the hearing aid must be replaced periodically since it is small and has only a limited life time of operation. In addition, the hearing aid must be removed from the ear periodically to allow it to be cleaned of ear wax and other contaminates. This not only adds to the cost of operating the hearing aid, but, since most hearing aids are used by elderly persons, it can be difficult for the person to replace the small battery in the small hearing aid. Therefore, it would be desirable to have a hearing aid which is inexpensive with

regard to both the structure of the parts of the hearing aid and its method of making, and which can be easily used by the person, particularly the elderly.

Summary of the Invention

The present invention is directed to a hearing aid which includes a circuit for receiving and amplifying the sound, and a shell surrounding the circuit. An ear mold of a soft, pliable material surrounds the shell and is adapted to fit into and mold to the ear of a person.

The present invention is also directed to a method of making hearing aids wherein electronic components, speakers, microphones and batteries are mounted onto an elongated flexible circuit strip to form along the strip the electronics assembly of a plurality of hearing aid. The flexible printed circuit strip is cut apart to form the assemblies of individual electronics of a hearing aid on a printed circuit, and each assembly is inserted into a cylindrical shell. Each shell containing an assembly is then inserted into an opening in a separate ear mold of a soft, durable and compliant material.

Brief Description of the Drawings

Fig. 1 is an exploded schematic view of the hearing aid of an embodiment of the present invention;

Fig. 2 is a sectional view of the assembled hearing aid of an embodiment of the present invention;

Fig. 3 is a schematic view of the electronics of the hearing aid of an embodiment of the present invention;

Fig. 4 is a flow chart showing a method of assembling the hearing aid of an embodiment of the present invention;

Figs. 5a and 5b are charts showing the various responses of the amplifier circuit which can be used in the hearing aid of an embodiment of the present invention.

Detailed Description

Referring initially to Figs. 1 and 2 of the drawings, the hearing aid of an embodiment of the present invention is generally designated as 10. Hearing aid 10 comprises an electronic assembly 12, a shell 14 and an ear mold 16. As shown in Fig. 3, the electronic assembly 12 includes a microphone 18 which is adapted to receive the sound and convert the sound into electrical signals. The microphone 18 is connected to the input of a signal processing circuitry 20 which amplifies the sound, diminishes any undesirable back ground noise and which can adjust the sound according to the particular needs of the hearing of the user. The output of the signal processing circuitry is connected to a speaker 22 which converts the output signals to sound and directs the sound into the ear of the user. A suitable battery 24 of any desired structure is connected to the signal processing circuitry 20 to operate the circuitry 20.

As shown in Figs. 1 and 2, the electronics 12 includes a flexible printed circuit 26 having a base 26a and upright arms 26b and 26c at its ends. The flexible printed circuit 26 also includes therein paths of a conductive metal (not shown). The microphone 18 is mounted on the upright arm 26b at one end of the printed circuit 26, and the speaker 22 is mounted on the upright arm 26c at the other end of the printed circuit 26. The components 28 of the signal processing circuitry 20 and the battery 24 are mounted on the base 26a of the printed circuit 26 between its ends. The microphone 18 can be any very small microphone which is presently on the market or can be a silicon microphone in which the diaphragm of the microphone 18 is a thin layer of silicon.

The signal processing circuitry 20 can be of any well known type which will provide the desired amplification. For a very short operating hearing aid 10, such as for a three day operation, the signal processing circuitry 20 can be of the type which will provide amplification with fixed gain and frequency response. A simple, low-cost class-A amplifier can be used. For

a longer lasting hearing aid 10, such as a 30 day device, the signal processing circuitry 20 can be of the type which contains a two-channel amplifier with signal compression. One channel can process the lower frequency spectrum while the other channel can process the higher frequency spectrum. To extend battery life, a more efficient class-D amplifier can be used. For any type of signal processing circuitry 20, integrated circuits that perform the required signal processing should be used and are readily available. To achieve the different responses, different values of passive components, such as resistors and capacitors, can be used. The speaker 22 can be of any type of small speaker readily available. The battery 24 can be of any small type having sufficient power to operate the signal processing circuitry used.

The shell 14 is a flexible hollow cylindrical element that is adapted to house and protect the electronics 12. The shell 14 is of a molded, flexi plastic material and contains means, such as ribs 15 shown in Fig. 2, to orient and retain the electronics 12 therein. The shell 14 is of a material which protects the electronics 12 from moisture and mechanical damage. The shell 14 also provides acoustical features for facilitating incoming and outgoing sound, and has external features, such as ribs 17, which help retain it in the earplug 16.

Ear mold 16 is of a soft, durable and compliant material. It can be of a cold-cured methacrylate, heat-cured methacrylate, heat-cured silicone, polyvinyl chloride copolymer or polyethylene co-polymer. The ear. mold 16 has an inner opening 16a into which the shell 14 containing the electronics 12 is inserted and retained. The outer configuration of the ear mold 16, such as its shape and size, is such that it can be readily inserted in the ear channel of the user and which will flexibly mold itself to the shape of the ear channel. Since the ear mold 16 is of a compliant material, the pressure of the ear mold 16 against the wall of the ear channel produces a good fit needed to prevent feedback and to help retain the hearing aid 10 in the ear. It has been found that ear molds of soft material are superior to those of hard material in the

attenuation of feed back acoustics.

Referring to Fig. 4, there is illustrated a method of assembling the hearing aid 10 of an embodiment of the present invention. A flexible circuit 26 is feed from a reel along with the various components 28 which made up the electronics 12. Including microphones 18, loudspeakers 22 and batteries 24, into an assembly apparatus 30. The assembly apparatus 30 assembles the components onto the flexible circuit to form a strip containing a plurality of the electronics.12. The completed assembly is mounted on a reel to form a reel 32 of the circuits.

The flexible circuit assemblies of the reel 32 are then fed along with shells 14 into an assembler 34 where the electronics 12 are cut apart from the reel, and each electronics 12 is formed and inserted into a shell 14. The shell assembly is then inserted into a package 36 which is hermetically sealed and contains a gas which will protect the shell assembly from the atmosphere and extinguish battery activity.

The ear molds 16 are molded in a suitable molding apparatus and packaged in a hermetically sealed package 38. The ear molds 16 are preferably molded in several different sizes so that a suitable size can be used for each user of the hearing aid 10.

The signal processing circuitry 20 of the electronics 12 is designed to accommodate high-frequency hearing losses and flat-frequency hearing losses in the mild to moderate ranges. The signal processing circuitry 20 for different electronics 12 is made to provide different audiological responses. Figs. 5a and 5b are charts showing the various responses which are provided by the different electronics 12 which are made in the process of an embodiment of the present invention. Fig. 5a shows the responses for a three day device which has a fixed gain and frequency response, and Fig. 5b shows the responses for a 30 day device which has a two-channel amplifier. In each of Figs. 5a and 5b, the columns represent different amplifier gains with column A being the lowest gain and column C being the highest gain. The rows represent

different frequency responses with row 1 being a flat response, row 2 a mild high frequency boost and row 3 the moderate high frequency boost. Thus, in making the signal processing circuitry 20, different components are used so as to make up a fixed number of circuits having different gains and frequency responses as shown in Figs. 5a and 5b. The different circuits are marked according to the charts of Figs. 5a and 5b according to gain and frequency response, such as A1, A2, A3, B1, etc.

The last step in making the hearing aid 10 of an embodiment of the present invention is done by an audiologist or physician after the hearing of the user is tested and it is determined what type of audiological response is required. The audiologist or physician checks the charts shown in Figs. 5a and 5b and picks the signal processing circuitry 20 which will provide the audiological response required by the user. The audiologist/physician then picks the shell assembly which contains the desired electronics, and picks an ear mold 16 of the appropriate size for the user. The shell assembly is then inserted into the ear mold 16 and the hearing aid 10 is ready to be inserted in the ear of the user.

In the hearing aid 10 of an embodiment of the present invention, the signal processing circuitry 20 has fixed audio characteristics and is made in a limited number of acoustical formats. Also, the acoustical format is preprogrammed in the electronics manufacture so that no potentiometers are needed for adjusting the circuit. In addition, the units are used only for the life of the battery. Thus, no on/off switch is used. Therefore, it is of simple design having a minimum number of components and is easy to assemble on an automatic basis. The signal processing circuitry 20 and the entire electronics 12 is inexpensive because it can be easily made in large volumes and economy of scale. The electronics 12 is encased in a simple hollow shell which is easy to assemble. Also, the ear mold 16 is of simple design and of a soft, pliable material so as to be inexpensive. Thus, the entire hearing aid 10 is of a minimum number of

inexpensive parts and is easy to assemble so that the hearing aid 10 is relatively inexpensive compared with presently used hearing aids. Since the hearing aid 10 is so inexpensive it is disposable. Therefore, when the battery 24 of the hearing aid 10 dies out, instead of replacing the battery 24, the whole hearing aid can be disposed of and replaced with a completely new hearing aid 10. Thus, there is provided by an embodiment of the present invention, a hearing aid 10 which is inexpensive to manufacture so as to be disposable. However, the hearing aid 10 still has all of the audio characteristics required by the user and has a high reliability. Furthermore, since the hearing aid of the present invention is small and has a soft, pliable ear mold, it is more comfortable to wear. In addition, since it is disposable, it requires no service calls for major cleaning and adjdustment.

What is claimed is:

1. A hearing aid which is adapted to be inserted in the ear of a user comprising:

an electronic circuit for receiving and amplifying sound;

a shell surrounding the circuit; and

an ear mold of a soft pliable material surrounding the shell and adapted to fit into and mold to the ear of a user.

2. The hearing aid of claim 1 wherein the shell includes means on its inside to orient and retain the electronic circuit therein.

3. The hearing aid of claim 1 in which the electronic circuit comprises a microphone, a speaker, signal processing circuitry and a battery.

4. The hearing aid of claim 3 in which the electronic circuit includes a printed circuit board on which the microphone, speaker, signal processing circuit and battery are mounted and electrically connected together.

5. The hearing aid of claim 3 in which the signal processing circuitry includes an amplifier.

6. The hearing aid of claim 1 in which the ear mold is of a soft pliable material selected from the group of cold-cured methacrylate, heat-cured methacrylate, heat-cured silicone, polyvinyl chloride copolymer and polyethylene co-polymer.

7. A method of making hearing aids comprising the steps of:

mounting electrical components, speakers, microphones and batteries onto an elongated flexible circuit strip to form along the flexible printed circuit strip the electronic assembly of a plurality of hearing aids;

cutting the flexible printed circuit strip apart to form the assemblies of the individual electronics of a hearing aid on a printed circuit, and inserting each assembly into a

separate cylindrical shell; and

then inserting a shell containing an assembly into an opening in an ear mold of a soft, durable and complaint material.

8. The method of claim 7 wherein after the electrical components are mounted on the flexible printed circuit strip, the strip is mounted on a reel.

9. The method of claim 8 wherein the flexible printed circuit strip on the reel is fed with shells into an assembler which cuts the strip apart into the individual assemblies and inserts each assembly into a separate shell.

10. The method of claim 9 wherein after the assemblies are inserted into the shells, the shells containing the assemblies are placed in a package which is hermetically sealed and which contains a gas which will protect the shell assembly from the atmosphere and extinguish battery activity.

11. The method of claim 7 in which the electronic components are assembled to form individual electronics having fixed audio characteristics in a limited number of different acoustical formats, and the shell containing the electronics having the appropriate acoustical format for a particular user is inserted in an ear mold.

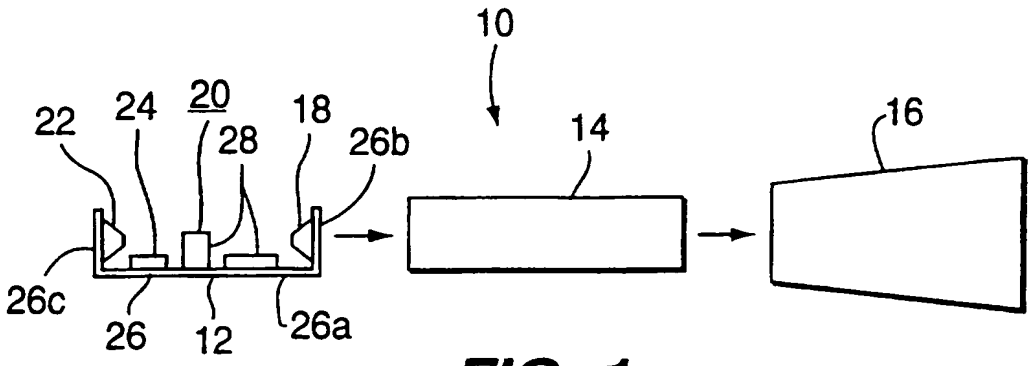


FIG. 1

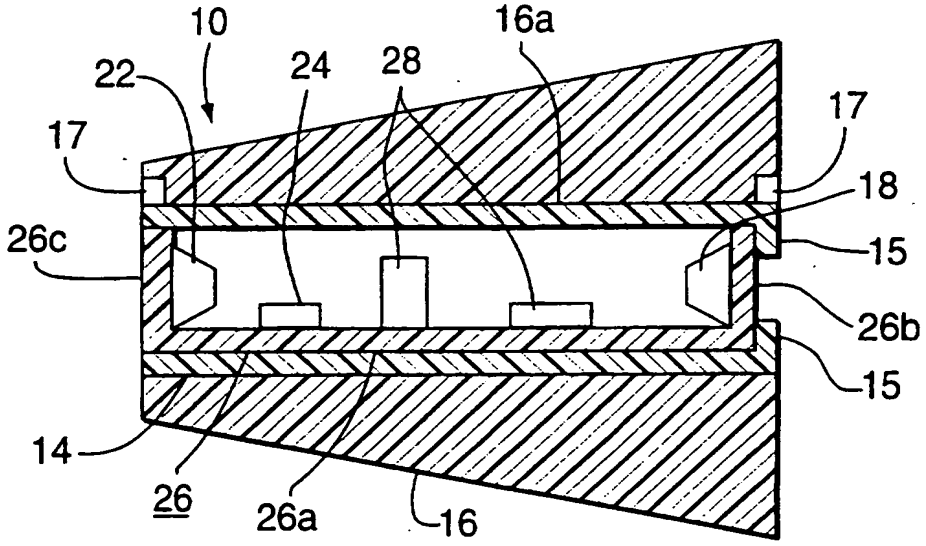


FIG. 2

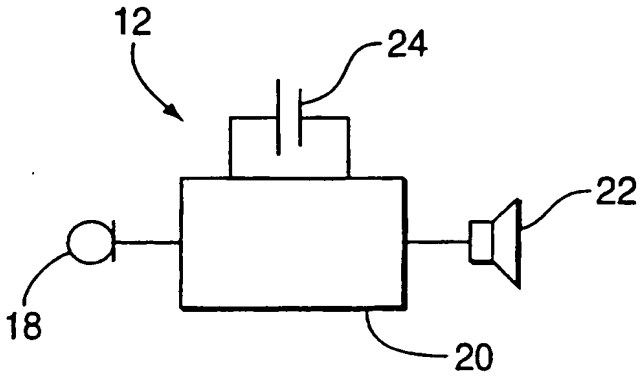


FIG. 3

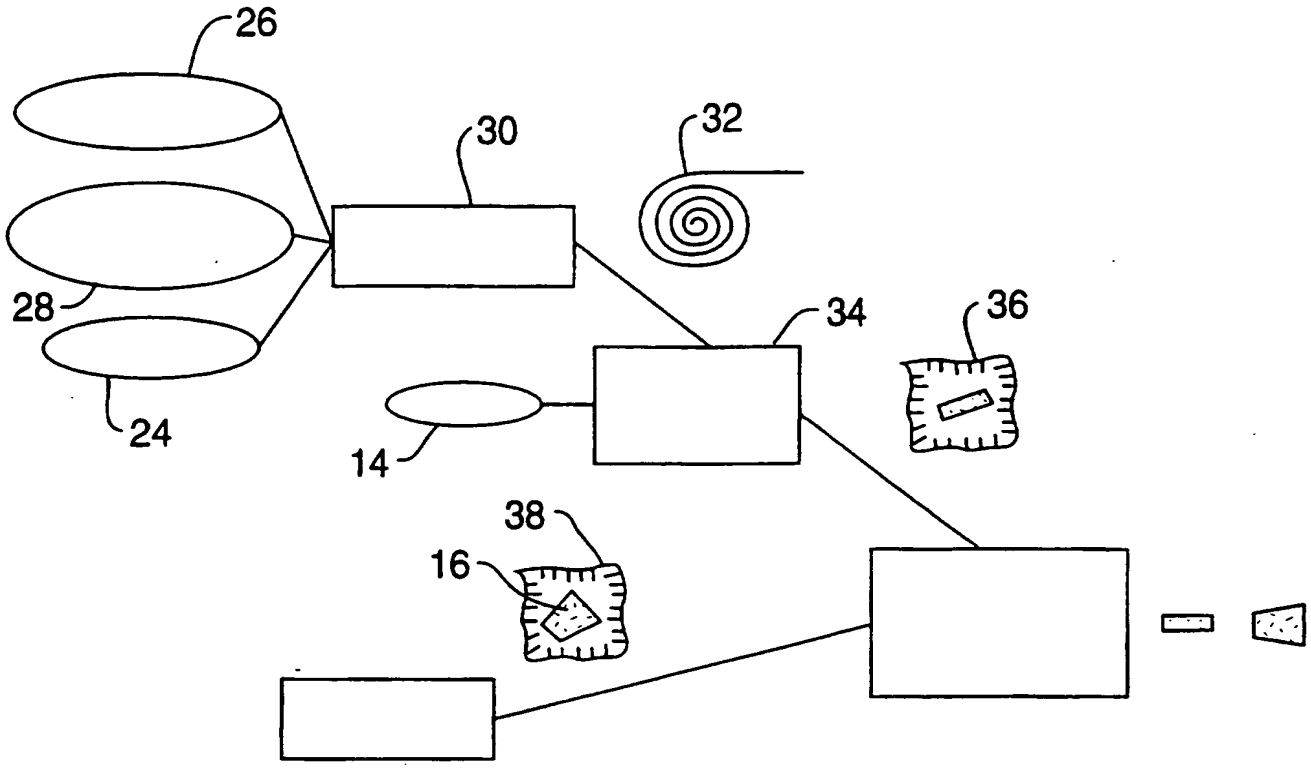


FIG. 4

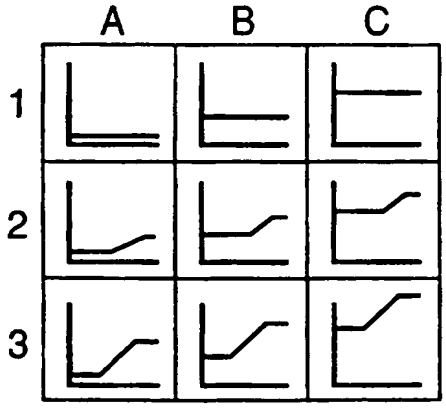


FIG. 5a

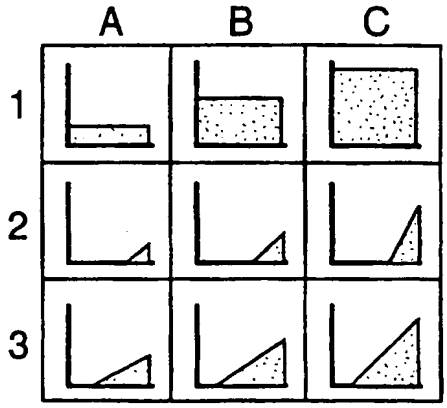


FIG. 5b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/03481

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04R 25/00
US CL :381/68.6; 29/832, 841
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 381/60, 68, 68.3, 68.6; 29/416, 417, 832, 834, 836, 841.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,012,520 (STEEGER) 30 April 1991, figure 3	1-11
Y	US, A, 4,969,534 (KOLPE ET AL.) 13 November 1990 see column 5, line 45.	1-5
Y	US, A, 4,716,985 (HAERTL) 05 January 1988, see column 2, lines 23-24.	6
Y	US, A, 5,146,051 (HERMANN) 08 September 1992, column 5, lines 3-4.	6
Y	US, A, 5,141,455 (PONN) 25 August 1992, column 5, lines 37-60.	7-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 MAY 1997	11 JUL 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
HUYEN LE
Telephone No. (703) 305-4844

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/03481

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

I. Claims 1-6, drawn to an apparatus of a hearing aid.
II. Claims 7-11, drawn to a method of making hearing aids.
Inventions II and I are related as process of making and product made. The inventions are distinct if either or both of the following can be shown:(1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process. In the instant case, the process can be made by different means.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.